APPENDIX A

Habitat Evaluation Procedures (HEP) methods, assumptions, and calculations for determination of acreage and habitat value impacts of the Prospect Island Restoration Project.

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I. Acreage

A. Methods

For the HEP analysis, the 1993 baseline cover-type mixture was assumed to be constant for the period of analysis for without-project conditions. Further, since the site experiences occasional flooding due to use of the Yolo Bypass and/or levee breaching, we assumed the without-project condition to be represented by the long-term average condition: primarily unflooded, agricultural, cover-type and a component of shallow flood cover resulting from levee failure and incomplete drainage. Cover-types were mapped by planimetry of 1993 aerial photographs provided by the Corps, groundtruthed by several site visits. The total area measured from the outboard edge of the levees, plus a 15-foot-wide zone outside the levee which extends over the water (i.e., the potential area of SRA cover), was previously estimated from paper maps and Corps communication to be 1424.96 acres. The 1316 acres stated to be total area is correctly measured from the outboard edge of the levees (Mike Fujitsubo, personal communication), not the inner edge, as previously reported by the Corps. For several cover-types (SRA cover, upland, bare ground, shallow flood cover), initial estimates were revised based on remeasurement and/or different assumptions (explained below). For all remaining cover-types, the original areas measured in the maps were corrected for map error by multiplying by 0.929, the ratio of the actual total (1316 acres) divided by the measured area exclusive of outboard SRA cover (1416.96 acres).

A single earthwork alternative was evaluated using two post-project future scenarios (fut-A and fut-B). Fut-A was developed based on conservative estimates of habitat development, erosion of not more than 30%, and a minimal planting effort, and represents a reasonable view of the current plans. The planting plan has not been specifically outlined. However, Corps staff have indicated the current plan is to plant about 20% of the interfaces of islands and benches with a row of willows and/or tules; none of the island interiors or marsh plain will be planted. Fut-B is based on more optimistic habitat projections, not more than 10% erosion, and assuming a more intensive planting effort of about three times that which is currently proposed. Additional planting could include more of the interface, a wider riparian area on the benches and islands, levee slopes above these benches, as well as some portion of the marsh plain to accelerate vegetative development.

The with- and without-project cover-types used in the acreage and habitat value analyses correspond to those described in the resource category designation in the discussion section of this report. Minor adjustments to the with-project acreages for the tidal emergent marsh values in Table 2 were needed for the HEP analysis, to preclude double counting of acreage where tidal marsh was expected to overlap with SRA cover; the final acreages used in the HEP calculations are presented in Table 1 of the main report. The locations of most existing cover-types are shown in Figures 2 and 3 in the main report. All HEP assumptions were reviewed by Corps staff.

B. Calculations

1. Upland

Most uplands were confined to the inboard side of the levees due to the presence of other cover types (riprap, riparian forest, or scrub-shrub) on the outboard side. These uplands were estimated to equal the perimeter levee distance (39,249 feet) times 30 feet, or about 27 acres. The field borders consisted of 22 identified segments totalling 69,364 feet; assuming a width of

5 feet yields an estimate of about 7.9 acres. The Corps provided an estimate of the levee area to be 64 acres, of which 15.76 acres is bare ground, 16.37 acres is riparian, and the remainder is upland (31.87 acres). Thus, total uplands in field borders and levee sides is about 39.8 acres.

During construction, we assume that all except 10 acres becomes barren, and then left to recover after construction. However, due to reduced maintenance and planting, some upland will be converted to riparian cover; we set future upland to 24 and 12 acres for fut-A and fut-B, respectively

2. Non-tidal Open Water

The only open water is limited to the east-west ditch located at the southernmost portion of the project site between the central ditch and the pump station. We estimate this area to be 1,654 feet long and 20 feet wide, or about 0.76 acres, corrected to 0.7 acres.

There would be no non-tidal open water with the project.

3. Riparian Forest and Riparian Scrub-shrub

For the majority of the project site, scrub-shrub was interspersed among riparian forest (i.e., along the ship channel). Because of this interspersion, and because the selected models are applicable to both cover-types, scrub-shrub and forest were evaluated as a single unit, consisting of the sum of individual trees, narrow rows of trees along ditchlines, and mature trees along the ship channel. We estimate a total of 24 individual trees with a crown width of 15 feet (176 square feet (sq ft) each), or 4,230 sq ft total), 1,400 feet of irrigation ditch lined with young willows within the island (140,000 sq ft), and 20,800 sq ft of riparian habitat at the extreme north and south ends of Miner Slough; the total of these areas is 0.5 acres (adjusted downward to 0.47 acres). Added to the 15.9 acres measured (15.2 acres adjusted) of forest and scrub-shrub along the ship channel, the total adjusted area is assumed to be 15.67 acres. We estimate that about 7.4 acres would qualify as riparian forest, and the remainder (8.27 acres) would be scrub-shrub. The 0.47 acres on the interior of the island would be lost during construction of the project, leaving 7.8 acres scrub-shrub after construction.

During construction, earthwork will be done such that elevations in the riparian/upland range will be about 100 acres. Of this, 15.2 acres is already riparian, 15.8 acres is bare ground, and 31.9 acres is upland; thus, the remainder of 37.1 acres is the portion in the riparian elevation range that would be on existing or created levee berms and islands. Under fut-A, we assume that an additional 15 feet of the inboard side of the levee will convert from upland to riparian (10.9 acres), so the total is 15.2 + 37.1 + 10.9 or 63.2 acres, of which 48 acres is newly created. Under fut-B, we assume that riparian vegetation would encroach or be promoted on 30 feet up the levee slope on the inboard side, and maintenance would be relaxed such that riparian could establish on 15 feet of the outboard side, tripling the conversion of upland to riparian (i.e., to 32.7 acres). The total riparian for fut-B is 15.2 + 37.1 + 32.7, or 85 acres, of which 69.8 acres is newly created.

After 5 years, erosion losses of 30% reduce the newly created riparian area to 44.2 acres for fut-A, and losses of 10% reduce this area to 80.8 acres for fut-B.

4. Non-tidal Emergent Marsh

This cover-type is present in four ditch segments totalling 15,380 linear feet, and which vary from 4 to 10 feet in width. Based on groundtruthed widths, we estimate 125,468 sq ft (2.9 acres, adjusted down to 2.7 acres) of this habitat exists at the site, all of which would be lost due to project construction, and none would be re-created.

5. Shallow Flood Cover

No direct information is available on the historical extent of shallow flood cover at the site, which would be expected to vary from year to year. The entire study site is designated as a type of farmed palustrine wetland, however, active pumping reduces the extent of flooding in most year-types. Based on discussion with a lessee (Tom Slater, Slater Farms) who had worked the area for a number of years, we estimate the minimum area of this cover-type to be 64.7 acres (adjusted down to 62.4 acres), situated in the southern end of the site (*see* Figure 2). However, flooding of the entire island about once every five years occurs due to levee failures. At such times, at least 300 acres on the norhern portion of the island becomes shallow flood cover until the breaches are repaired and the island is dried out. As a long term average, we set the shallow flood cover to 120 acres (60 acres from incomplete drainage every year plus 60 additional acres as an annual average from levee breaching, i.e., 300 acres every five years). This habitat would be lost due to project construction, and none of this cover-type would be re-created.

6. Shaded Riverine Aquatic Cover

The baseline area of SRA cover is calculated as the length of vegetated outboard levee (23,301 feet total for the ship channel and Miner Slough) multiplied by the maximum distance of overhead shade (15 feet). This yields SRA cover estimates of 2.6 and 5.4 acres on the ship channel and Miner Slough levees, respectively (corrected total of 7.4 acres). Although riprapped, sparse woody growth was evident in some areas along Miner Slough. The riprapped areas along the ship channel, and limited parts of Miner Slough did not support woody vegetation of any kind.

We assume that none of this SRA cover would be impacted, as the levee breaches are located in relatively barren areas of either levee. SRA area does not change under fut-A, but under fut-B, we assume that about 3,000 feet more SRA (1 acre) is created by planting/earthfill over the most heavily rip-rapped and/or maintained outboard levee sections which currently lack SRA.

7. Shaded Palustrine Aquatic Cover

In addition, it is estimated for both futures that about 37,100 feet of inboard levee perimeter and 10,860 feet of island edge would form new SPA cover; with an assumed 15-foot width, this would be 16.4 acres of shade which is subtracted from the emergent marsh elevation. Although the area is the same for both futures, fut-B suitabilities are higher (*see* with-project HSI section, below).

8. Bare Ground

Existing bare ground, including the perimeter levee road and path (37,100 x 15 feet), the central road (14,771 x 15 feet), and riprap on the ship channel (5,195 x 25 feet) constitute about 20.8 acres of the total.

Under fut-A, all but the perimeter road (12.8 acres) would be converted to other cover-types. Under fut-B, all but 3 acres (i.e., the riprapped area), including all perimeter roads, is assumed to be converted to additional riparian cover.

Erosion of the riparian cover-type area was assumed to occur within the first five years post-construction, to a maximum of 30% and 10% for fut-A and fut-B, respectively. These eroded areas are assumed to be bare ground.

9. Agriculture

The 1116.8 acres of agriculture was calculated as the total area (1,316 acres) less the baseline adjusted acreages of the seven aforementioned cover-types. It is assumed that no agriculture would remain with either restoration alternative.

10. Tidal Emergent Marsh

This cover-type is divided into two depth ranges that are treated separately in the HEP: shallow and deep tidal emergent marsh (termed sh-TEM and dp-TEM). The area which is denoted in the typical tule marsh range of -2.0 to +1.0 feet MWL is 317 acres, of which 16.4 is designated as SPA cover, leaving 300.6 as sh-TEM. Below this is 234 acres between -2.5 to -2.0 MWL, which is considered potential, or "deep" TEM; it occurs slightly below the expected elevation of this cover-type, and may or may not support marsh. Under fut-A, we assume that no dp-TEM forms (coverage does not exceed 30%), while under fut-B, we assume that 180 acres of this transition zone will support TEM exceeding 30%.

11. Mudflat

The extent of mudflat can only be roughly estimated. Mudflat does occur locally to the site, on islands within the CDFG property and Cache Slough Mitigation Area, both immediately south of the site. In contrast to San Francisco Bay, such flats are not typically extensive in the peripheral delta due to factors like reduced tidal amplitude and different inundation tolerances of the emergent plant species. Under fut-A, we assume that all 234 acres from -2.5 to -2.0 feet MWL is mudflat, and under fut-B, we assume that 54 acres of this is mudflat (coverage does not exceed 30%).

A summary of the cover-type distribution, and vegetation maps showing their locations are included in the main body of this document (Table 1; Figures 2 and 3).

II. Habitat Value

Habitat Evaluation Procedures (HEP) is a methodology which can be used to document the quality and quantity of available habitat for selected fish and wildlife species. HEP provides information for two general types of habitat comparisons: (1) the relative value of different areas at the same point in time; and (2) the relative value of the same area at different points in time. By combining the two types of comparisons, the impacts of proposed or anticipated land-use and water-use changes on habitat can be quantified. Similarly, any compensation needs (in terms of acreage) for a project can also be quantified, provided a mitigation plan has been developed for specific alternative mitigation sites.

A HEP application is based on the assumption that the value of a habitat for selected species or the value of a community can be described in a model which produces a Habitat Suitability Index (HSI). In calculating the HSI, several habitat variables are first measured and a corresponding Suitability Index (SI) assigned to the observed variables (using the notation V1, V2, etc.) based on a verified relationship between the level of the variable and its value to wildlife resources. The HSI is calculated through a mathematical combination of the SIs. This HSI value (from 0.0 to 1.0) is multiplied by the area of available habitat to obtain Habitat Units (HUs). The HUs and Average Annual Habitat Units (AAHUs) over the life of the Project are then used in the comparisons described above.

The reliability of a HEP application as a tool to assess habitat values is directly dependent on the ability of the user to assign a well-defined and accurate HSI to the selected evaluation elements or communities. Also, a user must be able to identify and measure the area of each distinct cover-type being utilized by fish and wildlife within the project area. Both the HSIs and the habitat acreages must also be reasonably predictable for future points in time. In HEP, the future conditions are referred to as Target Years (TYs).

A. Without-Project HSIs

It is assumed that the existing condition of the site is stable, such that habitat suitability indices will neither increase or decrease over time without the project. This assumption is reasonable considering the intensive management of the area through cropping, and maintenance of levees and irrigation systems. Except where noted, model variables were designated by interpretation of aerial and ground photographs, visits to the project site, and best professional judgement.

1. Agriculture

a. Ring-necked Pheasant (SCS 1980)

This model calculates a HSI as the minimum of the SIs for food, water, cover, reproduction, and interspersion. Selection of the SIs is based on categories of habitat conditions described in the model documentation.

V1 - *Food Value*: The study area fits the category "harvested grain seeds scattered and not abundant," however, the presence of field border weeds provides some compensation. An SI of 0.5 was selected.

V2 - *Water Value*: This SI is the average of availability (W1) and distance (W2) to water. Water is considered freely available year-round (W1 = 1.0), and at a distance of around 100 to 300 meters due to the proximity of agricultural lands to vegetated or unvegetated ditches (W2 = 0.6), thus, V2 = 0.8.

V3 - *Cover Value*: Referring to winter cover of scrubland, treeland, and/or dense, tall, persistant, herbaceous land, the study site may be considered relatively sparse, and similar to availability of water in distance (100 to 300 meters). A value of 0.6 is selected.

V4 - *Reproductive Value*:

R1 - The *disturbance regime* includes plowing between late April to late June, but some value is given due to unplowed field borders (R1 = 0.2).

R2 - The *herbaceous canopy cover* from mid-April through July is <20% due to cropping (R2 = 0.1).

R3 - The *height of herbaceous cover*, where present, is around 0.4 meters (R3 = 0.6)

V4 is the average of these (i.e., V4 = 0.3).

V5 - *Interspersion Value* is considered intermediate (SI = 0.5), defined as either cover or feeding areas present as "large units", and edge "considerably less than choice".

The HSI is equal to the minimum SI, or 0.3.

b. Red-Tailed Hawk (USFWS 1985)

Because the model applies specifically to grain crops, the HSI is adjusted by a relative value index of 75 percent, reflecting the fact that about 25 percent of the agricultural area is planted in other crop types.

V3 - *Perch Sites* consist of about 40 telephone poles along the central ditch, and about 10 other such spots. Thus the perch density is about 1 per 20 acres (SI = 0.2)

V5 - *Overwinter Management* could not be observed directly. Earlier in the year (June), freshly plowed areas were observed, and no residual food was observed after fall harvesting of wheat. If similar methods are assumed to apply to corn, the SI = 0.0.

V7 - *Nest Sites* (i.e., trees > 20 inches diameter at breast height) are not present on this cover-type (SI = 0.0).

V10 - *Distance between cover-types* is, on average about 0.75 miles, so the SI = 1.0 for this variable.

The food value is the average of V3 and V5 (i.e., 0.1). Because some variables have no value, a useable area is calculated as the product of the area and the average interspersion index calculated by the same curve as V10. Because of the close proximity of the ship channel, no adjustment is needed, however less is known about the proximity to appropriately managed grain fields. We assume this distance to be at least 1.5 miles. Thus, the food and reproductive values need to be modified by the lowest average interspersion index as a result of this distance (i.e., a V10 of 0.5). The HSI is 75% the minimum of these modified values, or about 0.04.

c. Red-Winged Blackbird (Short 1985)

V7 - *Presence of dense, sturdy herbaceous vegetation on upland site* - The corn and wheat may be considered "dense, tall herbaceous vegetation", so the SI is 0.1.

V8 - *Occurrence of disturbances like grazing, mowing, burning, and tilling on potential upland nest sites* - The cropping practices may be considered to be a disturbance, thus the SI is 0.0.

The HSI is the product of V7 and V8, and is 0.0.

d. Striped Skunk (SCS 1980)

V1 - *Food*, within 1 mile is less abundant (SI = 0.5).

V2 - *Water*, evaluated by the nearest surface body, is < 265 meters (SI = 1.0).

V3 - *Cover* is evaluated by four subvariables, as follows:

CR1 - *Den Sites* are scarce (SI = 0.0).

CR2 - *Rest Sites* are of a low density (SI = 0.2).

CR3 - *Uncultivated Margins* are scarce (SI = 0.1).

CR4 - *Crop Type* is about 40% favored (corn or sugar beets) and 60% not favored (safflower or wheat), so an SI of 0.4 is applied.

V3 is the average of the subvariables, and is 0.18.

V4 - *Interspersion* is characterized by a minimal amount of edge (SI = 0.5)

The HSI is the lowest SI, or 0.18.

2. Upland/Herbaceous Grassland

a. Meadowlark (USFWS 1988)

V1 - *Distance to Water* is about 300 feet, considering potential sources of water in ditches and channels (SI = 1.0).

V2 - *Height and density of herbaceous vegetation*, to the extent it occurs, is considered relatively tall and dense (SI = 1.0).

V3 - *Perch Abundance*, is considered much less than 1 per acre, consisting of some shrubs, telephone poles, and weeds; the minimum SI of 0.3 is assumed.

The HSI is the average of the SIs, and is calculated as 0.77.

b. California Vole (USFWS 1988)

V1 - *Herbaceous Vegetation Height* is considered at least 6 inches (SI = 1.0).

V2 - *Percent Herbaceous Cover* is considered 100% (SI = 1.0).

V3 - *Soil Type* is considered not silty/loamy and not friable (SI = 0.2).

The HSI is the average of the SIs, or 0.73.

c. Ring-Necked Pheasant (SCS 1980)

V1 - *Food Value*: Equivalent to agriculture (SI = 0.5).

V2 - *Water Value*: High availability and short distance to source (i.e., less than 100 meters); SI = 1.0.

V3 - *Cover Value*: Referring to winter cover of scrubland, treeland, and/or dense tall persistant herbaceous land, the study site may be considered relatively sparse, and similar to availability of water in distance (<100 meters). A value of 1.0 is selected.

V4 - *Reproductive Value*:

R1 - The *disturbance regime* includes some plowing between late April to late June, and annual herbiciding in some areas (R1 = 0.2).

R2 - The *herbaceous canopy cover* from mid-April through July is >80% (R2 = 1.0).

R3 - The *height of herbaceous cover*, where present, is around 0.4 meters (R3 = 0.6).

V4 is the average of these (i.e., V4 = 0.6).

V5 - *Interspersion Value* is considered intermediate (SI = 0.5), defined as either cover or feeding areas present as "large units", and edge "considerably less than choice".

The HSI is therefore equal to the minimum SI, or 0.5.

3. Riparian Forest and Riparian Scrub-shrub

a. Rufous-Sided Towhee (USFWS 1984)

V1 - *Shrub Cover* is estimated to be about 50% of the total (SI = 1.0).

V2 - *Shrub Height* is in excess of 3 feet (SI = 1.0).

V3 - *Lateral Screening* is rated as high (SI = 1.0).

V4 - *Tree Cover* is estimated to be about 50% of the total (SI = 1.0).

V5 - *Leaf Litter* is estimated, based on casual field inspection, to be 50% of ground cover (SI = 0.5).

V6 - *Humus Layer Thickness* was determined in the field to be closest to the "medium" rating, or about 0.5 inches (SI = 0.5).

The HSI is the average of the SIs, or 0.90.

b. **Striped Skunk (SCS 1980)**

V1 - *Food* within 1 mile is readily available (SI = 1.0).

V2 - *Water*, evaluated by the nearest surface body, is < 265 meters (SI = 1.0).

V3 - *Cover* is evaluated by two subvariables, as follows:

CR1 - *Den Sites* are readily available (SI = 1.0).

CR2 - *Rest Sites* are readily available (SI = 1.0).

V3 is the average of the subvariables, and is 1.0.

V4 - *Interspersion* is characterized by a moderate amount of edge (SI = 0.5)

The HSI is the lowest SI, or 0.5.

4. **Shallow Flood Cover**

a. **Wintering Mallard (USFWS 1985)**

V1 - *Overwinter Cropland Management*: Condition "c" is assumed to apply to this cover-type (i.e., fall discing). The SI for this condition is 0.2

V2 - *Percent area with 1-18 inches Water Depth*: Limited survey data on USGS quad sheets show a difference of no more than 3 feet between the base of the levees and the deepest part of the site. We estimate at least 90% in this depth range (SI = 0.9)

V3 - *Flood Frequency*: We assume annual flooding (SI = 1.0).

V4 - *Distance to Resting Cover*: The nearest rest cover would be either the tidal marshes about a mile away at the south end of Prospect Island or the emergent marshes on the ditch about a half mile north (SI = 1.0).

The formula: HSI = V4 x $(V1 \times V2 \times V3)^{1/3}$ yields an HSI of 0.26.

5. **Non-Tidal Emergent Marsh**

a. **Egret Guild (Roberts 1986)**

V1 - *Percent of area with water 10-23 cm deep*: The ditches are relatively steep sided and occasionally herbicided; this percentage does not exceed 10% (SI = 0.1).

V2 - *Percent of 10-23 cm deep zone with emergent or submerged vegetation*: Due to maintenance, we believe not more than 25% of this zone is vegetated (SI = 0.5).

V3 -*Percent of year that habitat area has water over surface* - The ditches contain water for more than 1/3 of the year, but not outside the growing season when the siphon is not in use (SI = 1.0).

V4 - *Percent of area with 20 - 50 cm tall herbaceous vegetation during the summer* - Although tall herbaceous vegetation occurs near to this cover-type in the form of crops and crop borders, the area itself is maintained by herbiciding and other maintenance (SI = 0.0)

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V5 - *Percent of area >50 m from a footpath or other source of disturbance* - about 100%; the area is frequently disturbed by machinery or other human disturbances throughout the year (SI = 0.0).

$$HSI = \frac{2[(V1 \times V2)^{1/2} \times V3] + 2(V4) + V5}{5}$$

$$= \frac{2[(.1 \times .5)^{1/2} \times 1] + 2(0) + 0}{5} = 0.09$$

6. Non-Tidal Open Water

a. Egret Guild (Roberts 1986)

V1 - *Percent of Study Area with Water 10-23 cm deep*: The ditches are nearly vertical and frequently herbicided; this value does not exceed 5% (SI = 0.05).

V2 - *Percent of 10-23 cm deep zone with emergent or submerged vegetation* - Due to intensive maintenance, we estimate no more than 5% of this zone is vegetated (SI = 0.05).

V3 - *Percent of year that habitat area has water over surface* - Located nar the drain pump, this water is essentially permanent (SI = 0.1).

V4 - *Percent of area with 20 - 50 cm tall herbaceous vegetation during the summer* - Although tall herbaceous vegetation occurs near to this cover-type in the form of crops and crop borders, the area itself is maintained by herbiciding and physical removal of vegetation(SI = 0.0)

V5 - *Percent of area >50 m from a footpath or other source of disturbance* - about 100%; the area is frequently disturbed by machinery or other human disturbances throughout the year (SI = 0.0).

$$HSI = \frac{2[(V1 \times V2)^{1/2} \times V3] + 2(V4) + V5}{5}$$

$$= \frac{2[(.05 \times .05)^{1/2} \times .1] + 2(0) + 0}{5} = 0.002 \text{ (rounded to zero)}$$

7. Shaded Riverine Aquatic (SRA) Cover

a. SRA Cover-type (Fris and DeHaven 1993)

SRA cover on the ship channel and Miner Slough were treated separately, as follows:

V1 - *Percent area of overhead shade* - We estimate the ship channel and Miner Slough areas receive about 50% and 15% overhead shade, respectively (SIs = 0.8 and 0.2).

V2 - *Percent area of instream cover* - We estimate the ship channel and Miner Slough areas possess 10% and 0% instream cover, respectively (SIs = 0.1 and 0.0).

V3 - *Instream cover composition* - The instream cover in the ship channel area is predominantly woody debris, with a minor component of submerged vegetation (SI = 0.8).

V4 - *Instream/overhead cover interaction* - We estimate the typical condition to be only overhead cover for both the ship channel and Miner Slough areas (SI = 0.5).

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V5 - *Substrate Composition* - The ship channel substrate is fine sediments (SI = 1.0), whereas the Miner Slough side is riprap (SI = 0.0).

V6 - *Water Depth* - We estimate the water depth 5 feet away from the bank to include, at some portion of the tidal cycle, the optimum depth of 2 to 4 feet (SI = 1.0).

The HSI is determined by the equation:

$$HSI = \frac{2(V1 + (V2 \times V3)) \times V4 + V5 + V6}{6}$$

HSIs of 0.52 and 0.23 were calculated for the ship channel and Miner Slough, respectively.

B. With-Project HSIs

The period of analysis is 51 years. HSIs were projected for 5, 10, 20, 30 and 50 years post-construction. The rationales for selection of maximum values and vegetative development for both future scenarios are provided below. Where not noted specifically, values for fut-A and fut-B are assumed to be the same.

1. Tidal Open Water

a. Inland Silverside (USFWS 1986)

V1 - *Lowest monthly mean dissolved oxygen* - It is assumed that the combination of tidal flushing, wind mixing, shallow depth, and primary production will maintain dissolved oxygen within the optimum range (>5 mg/l; therefore SI = 1.0)

V2 - *Mean salinity 21 March to 21 September* - The study site is essentially freshwater, so it may be assumed that salinity does not exceed 20 ppt (SI = 1.0).

V3 - *Length of spawning season* (number of days in the year that temperature is between 20 and 30°C) - This can fairly be assumed to be at least 75 days per year (SI = 1.0).

V4 - *Percent silt plus clay in sediments* - According to the suitability curves, percentages exceeding 80% would result in no value. However, the model's documentation presumes a correlation between grain size and organic content and current regime. This variable does not apply well to the Prospect Island site because the predominant clay soil texture does not necessarily covary with organic content, and because there is little sand input from upstream. This variable is neglected by assuming it to equal 1.0.

V5 - *Zooplankton Density in July to August* - There are no data presently available for this variable in tidal freshwater wetlands in the Delta region; the model allows an alternative equation which excludes this variable.

V6 - *Percentage of subtidal area covered by submerged aquatic vegetation* - Past studies of island reconstruction on Donlon and Venice Cut Islands did not include surveys of submerged aquatic vegetation. Although submerged vegetation does occur, its coverage in north Delta areas is probably limited by light penetration. Under fut-A, it is assumed that a maximum 5% coverage will be achieved by TY 10, while under fut-B, we assume this maximum coverage will be 10%, also by TY10.

V7 - Percentage of creek/bay shoreline vegetated by marsh grasses. The length of time to reach optimum shoreline cover (at least 80%) is 20 years under fut-A, and 10 years under fut-B.

Summary of Projected SIs, component scores and HSIs for the inland silverside model, by Target Year:

SI	TY1	TY6	TY10	TY21	TY31	TY51
V1	1.0			same		
V2	1.0			same		
V3	1.0			same		
V4	1.0			same		
V5				excluded		
V6(futA)	0.0	0.03	0.08		same	
V7(futA)	0.0	0.3	0.6	1.0	same	
V6(futB)	0.0	0.08	0.16		same	
V7(futB)	0.0	0.8	1.0		same	
WQ	1.0			same		
F (futA)	0.66	0.68	0.69		same	
F (futB)	0.66	0.72			same	
HSI(futA)	0.0	0.2	0.41	0.69	same	
HSI(futB)	0.0	0.55	0.72		same	

Water Quality Component (WQ) = $\frac{V1 + 2V2 + V3}{4}$

Food Component (F) = $\frac{2V4 + V6}{3}$

Cover (C) = V7

2. Tidal Emergent Marsh

a. Marsh Wren (Gutzwiller and Anderson 1987)

V1 -*Growth Form of Emergent Hydrophytes* - Category "1" is selected (i.e., cattails, cordgrasses, bulrushes), which has an SI = 1.0.

V2 - *Percent canopy cover by emergent vegetation* - There would be no cover immediately post-breach (SI= 0.0), increasing to 15, 40, and 80% at TYs 6, 11, and 21-51 for sh-TEM, and 5, 15, and 40% at TYs 6, 11, and 21-51 for dp-TEM.

V3 - *Mean Water Depth* - The mean depth range for tules would be around +1.0 to -2.0 MWL. It is assumed that about half of the acreage of this cover-type would occur at less than 15 cm mean depth and would have an average SI of 0.5. The other half is assumed to occur at optimal depths, so the overall SI for this variable would be 0.75 for sh-TEM. For the dp-TEM, this variable is 1.0.

V4 - *Percent Canopy Cover of Woody Vegetation* - The relatively shallow slope of the islands should minimize any woody vegetation cover. It is assumed to be near zero, although it is recognized that a minor component of woody vegetation may occur at the transition between tules and scrub-shrub and/or riparian forest (SI = 1.0).

HSI = $(V1 \times V2 \times V3)^{1/3} \times V4$; as follows:

SI	TY1	TY6	TY11	TY21	TY31	TY51
V1	1.0			same		
V2(shTEM)	0.0	0.03	0.08	1.0	same	
V2(dpTEM)	0.0	0.01	0.03	0.08	same	
V3(shTEM)	0.0	0.75			same	
V3(dpTEM)	0.0	1.0			same	
V4	1.0			same		
HSI(shTEM)	0.0	0.02	0.06	0.75	same	
HSI(dpTEM)	0.0	0.01	0.03	0.08	same	

b. Egret Guild (Roberts 1986)

V1 - *Percent of area with water 10 - 23 cm deep* - This model assumes an optimal condition if the depth falls in this region at any time in the tidal cycle. Because the water will fluctuate in actual depth from 0 to 2 feet in depth throughout the tule zone, so the SI = 1.0.

V2 - *Percent of 10 - 23 cm zone which has submerged or emergent vegetation* - The same percentages described above for marsh wren model variable V2 are assumed here, with a different SI curve (see values below).

V3 -*Percent of year that habitat area has water over surface* - Tidal conditions are optimal (SI = 1.0).

V4 - *Percent of area with 20 - 50 cm tall herbaceous vegetation during the summer* - This variable is generally applicable to higher marsh without surface water present; a minor proportion of the emergent marsh, about 5 %, would fit in this category (SI = 0.0).

V5 - *Percent of area >50 m from a footpath or other source of disturbance* - Access to the site will be controlled, minimizing disturbance via water or land traffic (SI = 1.0).

$$HSI = \frac{2[(V1 \times V2)^{1/2} \times V3] + 2(V4) + V5}{5}$$

The HSIs for tidal emergent marsh, egret guild model, are as follows:

SI	TY1	TY6	TY11	TY21	TY31	TY51
V1	1.0	---------------same---------------				
V2(shTEM)	0.5	0.65	1.0--------same----------			
V2(dpTEM)	0.5	0.55	0.65	1.0--------same---		
V3	1.0	---------------same---------------				
V4	0.0	---------------same---------------				
V5	1.0	---------------same---------------				
HSI(shTEM)	0.48	0.52	0.6--------same----------			
HSI(dpTEM)	0.48	0.50	0.52	0.6--------same---		

3. Shaded Palustrine Aquatic (SPA) Cover

a. SRA Cover-type (Fris and DeHaven 1993)

Three variables (V1-overhead cover, V2-instream cover, and V4-instream/overstream interaction), are assumed to be affected by initial planting intensity and subsequent growth), and the other three variables V3-instream cover composition, V5-substrate composition, V6-water depth) are constants. The formula is given above under without-project HSIs.

V1 - *overhead cover* -for fut-A, shade accrues slowly; 10% at TY6, 20% at TY11, 40% at TY21 and 75+% for TY31-51. Due to additional planting, shade increases faster in fut-B; 20% at TY6, 40% at TY20 and 75+% at TY11-51.

V2 - *instream cover* - cover values are the same as with V7-inland silverside (shoreline vegetation), applied to the SRA model for the SIs.

V3 - *instream cover composition* - constant; 0.4 is the SI assigned to aquatic vegetation.

V4 - *instream/overstream interaction* - for fut-A, the average value of this variable is 0.25 at TY6, 0.75 at TY11, and 1.0 for TYs 21-51. For fut-B, values increase faster, to 0.4 at TY6, 0.8 at TY11, and 1.0 at TY21.

V5 - *substrate composition* - These are fine sediments, thus a constant SI of 1.0 is assigned.

V6 - *water depth* - with an assumed 5:1 sideslope minimum; depths five feet from the water edge would be a maximum of 2 feet deep (SI = 1.0).

The following SIs pertain only to the interior levees and islands (the variables are defined above; *see* "without project conditions").

SI	TY1	TY6	TY11	TY21	TY31	TY51
				Fut-A		
V1	0.0	0.13	0.30	0.53	1.0----same	
V2	0.0	0.38	0.75	0.95----same-----		
V4	0.0	0.25	0.75	1.0------same----		
				Fut-B		
V1	0.0	0.26	0.53	1.0------same----		
V2	0.0	1.0	0.95-------same--------			
V4	0.0	0.4	0.8	1.0------same----		
				Constants		
V3	0.4-------------same---------------					
V5	1.0-------------same---------------					
V6	1.0-------------same---------------					
HSI(fut-A)	0.33	0.42	0.48	0.64	0.79---same	
HSI(fut-B)	0.33	0.42	0.58	0.79-----same----		

4. Riparian Forest and Riparian Scrub-Shrub

a. Rufous-sided Towhee (USFWS 1984)

V1 - *Percent shrub cover* - The time for shrub cover to reach optimal levels (60+% cover) is 20 years for fut-A, and 10 years for fut-B, due to differences in initial planting. Lack of or low intensity planting is expected to result in a delay in recruitment owing to windfetch erosion and/or lack of seed source.

V2 - *Shrub height* - It is assumed that the optimal height is attained, on average within 5 years (SI = 1.0 at TY6).

V3 - *Lateral screening* - For fut-A, values begin to exceed "low" levels at TY6, increasing linearly to "high" by TY20. For fut-B, "high" levels are achieved by TY10 due to additional plantings.

V4 - *Tree cover* - Tree cover increases linearly to a maximum of 80%, but takes 30 years for fut-A versus 20 years for fut-B due to additional plantings.

V5 - *Percent cover of leaf litter* - The assumptions and values are the same as for tree cover; litter may exceed tree cover in some cases but it is assumed that occasional windfetch and winter inundation will create some bare area.

V6 - *Humus layer thickness* - The assumptions and values are the same as for tree cover for same reasons as stated for V5.

The HSI is for rufous-sided towhee is determined as the average of the SIs, which for the above assumptions is (3V4 + V1 + V2 + V3)/6, as follows:

SI	TY1	TY6	TY11	TY21	TY31	TY51
V2	0.0	1.0----------	same	----------	----------	----------
			Fut-A			
V1	0.0	0.4	0.6	1.0-----	same	-----
V3	0.0	0.0	0.5	1.0-----	same	-----
V4	0.0	0.14	0.27	0.54	0.8--	same--
			Fut-B			
V1	0.0	0.8	1.0--------	same	--------	
V3	0.0	0.5	1.0--------	same	--------	
V4	0.0	0.2	0.4	0.8-----	same	-----
HSI(fut-A)	0.00	0.30	0.49	0.77	0.90--	same-
HSI(fut-B)	0.00	0.48	0.70	0.90----	same	-----

b. Striped Skunk (SCS 1980)

V1 - *Food*, within 1 mile would be absent initially, increasing linearly to high abundance by TY11. This would be equivalent for both future scenarios, even though more vegetation is expected on fut-B.

V2 - *Water*, evaluated by the nearest surface body, would be constant, at < 265 meters (SI = 1.0).

V3 - *Cover*, is evaluated as the average of two subvariables, den site, and rest site availabilities. It is assumed that this will increase in the same manner as *Food* above.

V4 - *Interspersion* would be a constant, and of similar value to existing conditions (SI = 0.5). Although there are additional cover-types in the restored project (e.g., mudflat, emergent marsh), these aquatic habitats are not of as high value as riparian to this evaluation species.

The HSI is the lowest SI, and would increase from 0.0 initially, increasing to linearly to 1.0 by TY11, where it would remain for the period of analysis.

5. Mudflat

As stated above, under fut-A, we assume that all 234 acres from -2.5 to -2.0 feet MWL is mudflat, and under fut-B, we assume that only 54 acres of this is mudflat. The same futures are used for both scenarios, with different areas.

a. Wintering Shorebird Guild (Roberts 1986)

V1 - *Percent of exposed mud at mean low water* - We have restricted the designation of areas to be treated with this model to areas between -3 and -2 feet MWL, which are unlikely to support emergent vegetation. The value is initially 100% (SI = 1.0), declining linearly to a minimum of 70% between TY10 and TY21 due to encroachment of vegetation.

V2 - *V4:* Omitted for use on the mudflat cover-type

V5 - *Distance from outer edge of site to outermost edge of land* - This suitability index is maximized (SI =1.0) for areas where the distance between the marsh/mudflat interface and the outer edge of mudflat is 400 meters or less; this would apply to all mudflat areas in the proposed project design.

V6 - *Distance to nearest loafing site* - In the proposed project, most islands and interior margins of the perimeter levee could, after a few years of herbaceousand woody growth, serve as loafing sites, and all mudflats are in sufficiently close proximity to these areas to assure maximum value (SI = 0 initially, and 1.0 by TY6).

V7 - *% of area >50 meters from a footpath or source of disturbance* - This criterion is met for all the mudflat (SI = 1.0).

The HSI for the wintering shorebird guild model is calculated by the formula:

$$HSI = \frac{(2V1 + (2(V5 \times V6)^{1/2} + V7)/3)}{3}$$

The HSI would be 0.67 initially, increasing to 1.0 for TY6-11, then dropping to 0.8 for TY21-51.

6. Uplands

a. California Vole (USFWS 1988)

We assume that values of created uplands will be the same as that for existing uplands (HSI = 0.73).

b. Meadowlark (Garrison 1988)

The created uplands will be mostly widened levees and higher areas on islands. Clearance of woody vegetation on levees is normally conducted as a maintenance procedure to prevent weakening and seepage caused by root structures. However, the function of the levees is altered by the construction of the project; the SRDWSC levee will not be maintained, and the only structural purpose of the Miner Slough levee would be as a windbreak to protect the Ryer Island levee. Thus, it is reasonable to assume that a limited amount of vegetation would be allowable on the Miner Slough levee, which would be sufficient to maximize the suitability index for perch sites (V3 = 1.0 when the number of perch sites per acre exceeds 1.0). This results in a higher HSI of 1.0 for uplands with the project.

c. Ring-necked Pheasant (SCS 1980)

The created uplands are likely to be of greater value than are existing uplands for the reproductive value index in that these uplands will be undisturbed (R1 = 1.0), herbaceous height will likely exceed 0.45 meters (R3 = 1.0); a V4 of 1.0 is estimated. It is anticipated that a reduction of herbicide maintenance or other disturbance with the project would increase the food value (V1 = 0.8). The HSI is the least of the SIs, or 0.8.

C. Results

With the exception of uplands, separate HEP model runs were performed to evaluate habitat losses of existing cover-types and habitat gains of created cover-types. Table A-1 shows the baseline HSIs and with- and without-project areas of the *existing* cover-types; the riparian cover in this table does not include the gains due to the project, only that which exists now. The loss of 0.4 acre is along ditchlines within the site interior. Tables A-2 and A-3, representing fut-A and fut-B, respectively, provide the input variables for all *created* cover-types (including new riparian on berms/islands/levee slopes), and for uplands (showing net losses due to gains in riparian area). The last 3 pages are the "Form D" outputs used to determine net AAHU gains or losses, as shown in Table 4 of the main report.

Table A-1. Summary of HEP model input variables for determination of habitat value changes due to cover-types replaced by the Prospect Island Restoration Project (existing uplands were evaluated with created uplands)				
Cover-type	Model	HSI	Acres without project	Acres with Alt 1A or 1B
agriculture	redwinged blackbird	0	1116.8	0
	ring-necked pheasant	0.3	1116.8	0
	red-tailed hawk	0.04	1116.8	0
	striped skunk	0.18	1116.8	0
riparian on ditchlines and exterior of levees only	rufous-sided towhee	0.9	15.2	14.8
	striped skunk	0.5	15.2	14.8
shallow flood cover	wintering mallard	0.26	120	0
non-tidal emergent marsh	egret guild	0.09	2.7	0
non-tidal open water	egret guild	0.002	0.7	0
SRA on ship channel	SRA cover-type	0.52	2.4	2.4
SRA on Miner Slough levee	SRA cover-type	0.23	5.0	5.0

Table A-2. Summary of HEP Model input varibles for determination of habitat value gains due to cover-types created by the Prospect Island Restoration Project under fut-A (conservative scenario); existing and created uplands were evaluated together.

Cover-type	Model	area (ac)	Habitat Suitability Indices (HSIs) TY0	TY1	TY6	TY11	TY21	TY31	TY51
tidal open water	inland silverside	665	0	0	0.2	0.41	0.69	0.69	0.69
shallow tidal emergent marsh	marsh wren	300.6	0	0	0.02	0.06	0.75	0.75	0.75
shallow tidal emergent marsh	egret guild	300.6	0	0.48	0.52	0.6	0.6	0.6	0.6
deep tidal emergent marsh	marsh wren	0	---------------none present-----------------						
deep tidal emergent marsh	egret guild	0	---------------none present-----------------						
SPA on islands and interior levees	SRA cover-type	16.4	0	0.33	0.36	0.48	0.64	0.79	0.79
riparian on islands and interior levees	rufous-sided towhee	varies	0	0	0.3	0.49	0.77	0.9	0.9
	striped skunk		0	0	0.5	1	1	1	1
mudflat	wintering shorebird guild	234	0	0.67	1	1	0.8	0.8	0.8
upland	western meadowlark	varies	0.77	0	1	1	1	1	1
upland	California vole		0.73	0	0.73	0.73	0.73	0.73	0.73
upland	ring-necked pheasant		0.50	0	0.80	0.80	.80	.80	.80
riparian area by target year			0	48	33.6	33.6	33.6	33.6	33.6
upland area by target year			39.8	10	12	12	12	12	12

Table A-3. Summary of HEP Model input varibles for determination of habitat value gains due to cover-types created by the Prospect Island Restoration Project under fut-B (optimistic scenario); existing and created uplands were evaluated together.

Cover-type	Model	area (ac)	Habitat Suitability Indices (HSIs)						
			TY0	TY1	TY6	TY11	TY21	TY31	TY51
tidal open water	inland silverside	665	0	0	0.55	0.72	0.72	0.72	0.72
shallow tidal emergent marsh	marsh wren	300.6	0	0	0.02	0.06	0.75	0.75	0.75
shallow tidal emergent marsh	egret guild	300.6	0	0.48	0.52	0.6	0.6	0.6	0.6
deep tidal emergent marsh	marsh wren	0	0	0.01	0.03	0.08	0.08	0.08	0.08
deep tidal emergent marsh	egret guild	0	0	0.48	0.50	0.52	1	1	1
SPA on islands and interior levees	SRA cover-type	16.4	0	0.33	0.42	0.58	0.79	0.79	0.79
riparian on islands and interior levees	rufous-sided towhee	varies	0	0	0.48	0.7	0.9	0.9	0.9
	striped skunk		0	0	0.5	1	1	1	1
mudflat	wintering shorebird guild	54	0	0.67	1	1	0.8	0.8	0.8
upland	western meadowlark	varies	0.77	0	1	1	1	1	1
upland	California vole		0.73	0	0.73	0.73	0.73	0.73	0.73
upland	ring-necked pheasant		0.50	0	0.80	0.80	0.80	0.80	0.80
riparian area by target year			0	69.8	62.8	62.8	62.8	62.8	62.8
upland area by target year			39.8	10	12	12	12	12	12

Form D: Net Change in AAHU's   Date: 03/07/1997

Study Name: PROSPECT ISLAND RESTORATION
Action: PA 2 (with project)   FUT-A (CONSERVATIVE)
Compared To: PA 1 (without project)   CONTINUED FARMING
Period of analysis: 51

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	TOW SILVERSIDE	368.03	0.00	368.03
2	SH-TEM MARSH WREN	157.96	0.00	157.96
3	SH-TEM EGRET GUILD	173.64	0.00	173.64
4	DP-TEM MARSH WREN	0.00	0.00	0.00
5	DP-TEM EGRET GUILD	0.00	0.00	0.00
6	SPA (SITE INTERIOR)	10.45	0.00	10.45
7	RIP R-S TOWHEE	23.59	0.00	23.59
8	RIP SKUNK	30.03	0.00	30.03
9	MUD WINT SHOREBIRD G	194.53	0.00	194.53
10	UP MEADOWLARK	22.35	30.65	-8.30
11	UP VOLE	16.72	29.05	-12.34
12	UP R-N PHEASANT	17.85	19.90	-2.05

Form D: Net Change in AAHU's

Date: 03/07/1997

Study Name: PROSPECT ISLAND RESTORATION
Action: PA 3 (with project) FUT-B (OPTIMISTIC)
Compared To: PA 1 (without project) CONTINUED FARMING
Period of analysis: 51

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	TOW SILVERSIDE	434.86	0.00	434.86
2	SH-TEM MARSH WREN	157.96	0.00	157.96
3	SH-TEM EGRET GUILD	173.64	0.00	173.64
4	DP-TEM MARSH WREN	12.63	0.00	12.63
5	DP-TEM EGRET GUILD	101.51	0.00	101.51
6	SPA (SITE INTERIOR)	11.27	0.00	11.27
7	RIP R-S TOWHEE	48.57	0.00	48.57
8	RIP SKUNK	55.82	0.00	55.82
9	MUD WINT SHOREBIRD G	44.89	0.00	44.89
10	UP MEADOWLARK	14.75	30.65	-15.89
11	UP VOLE	10.82	29.05	-18.23
12	UP R-N PHEASANT	11.77	19.90	-8.13

Form D: Net Change in AAHU's

Date: 02/25/1997

Study Name: PROSPECT ISLAND RESTORATION
Action: PA 2 (with project) EITHER ALTERNATIVE
Compared To: PA 1 (without project) CONTINUED FARMING
Period of analysis: 51

Evaluation Species ID#	Name	AAHU's With Action	AAHU's Without Action	Net Change
1	AG R-W BLACKBIRD	0.00	0.00	0.00
2	AG R-N PHEASANT	3.28	335.04	-331.76
3	AG R-T HAWK	0.44	44.67	-44.23
4	AG SKUNK	1.97	201.02	-199.05
5	RIP R-S TOWHE LEVEE	13.32	13.68	-0.36
6	RIP SKUNK LEVEE	7.40	7.60	-0.20
7	SFC WINT MALLARD	0.31	31.20	-30.89
8	NTEM EGRET GUILD	0.00	0.24	-0.24
9	NTOW EGRET GUILD	0.00	0.01	-0.01
10	SRA SHIP CHANNEL	1.25	1.25	0.00
11	SRA MINER SLOUGH	1.22	1.22	0.00

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